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The Development of a Measure of Complex Concepts

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ABSTRACT

Because there is a need to measure performance of pupils with complex concepts, the Slide Sorting Task was developed to measure performance on complex concepts of freedom, non-freedom, justice, non-justice. The development of this instrument was presented along with the results of item analyses with several groups of Ss ranging from age seven through adults. The utility of the instrument was shown as a means of differentiating instructional procedures similar to those in regular classrooms. The instrument was shown to differentiate performances of abstract and concrete thinkers and to produce improved performances as a function of increases in age level.

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THE DEVELOPMENT OF A MEASURE OF COMPLEX CONCEPTS

Many teachers are concerned about the learner's acquisition of concepts in school settings. They are concerned about the types and kinds of concepts to be learned, the ways in which different learners acquire concepts, and the different strategies that might be employed to facilitate the acquisition of concepts. A number of teachers are aware of the vast and diverse research literature that has accumulated. Much of this literature is based upon the attainment of conjuctive and disjuctive concepts which are formed with combinations of color, shape, size, number, and types of borders. While the relationships that are defined in this manner are important for the researcher, these combinations of attributes are not the typical kinds of concepts taught by teachers in their classrooms. A striking exception, of course, would be the uni-dimensional concepts commonly taught to young children, such as the color, red, or the shape, triangle.

Although there are studies incorporating Piagetian tasks and research studies that have used concepts that are similar or identical to the types of concepts taught in the schools, for example, Atkin (1961), Johnson (1964), King (1963), Nelson (1958), and Olson (1963), there is a need to develop conceptual learning tasks that are more congruent with the kinds of concepts taught in the schools. Thus, a number of complex concepts that have long been incorporated in the curricula of the schools need to be studied if the research efforts are to have greater applicability for the classroom teacher.

The three principal purposes for this paper are to:

1. Present a descriptive narrative of the development of an instrument to measure the complex concepts identified as freedom, non-freedom, justice, and injustice.

2. Present descriptive data relative to pupil performance on the instrument at various age levels identified as seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, seventeen, and eighteen year olds as well as adults.
3. Present the findings of two research studies that have used the instrument or a modified form of the instrument.

The Instrument

Early developmental efforts of the concept learning task which incorporated the complex concepts of justice, nonjustice, freedom, and nonfreedom led to the identification of a large pool of exemplars for each of the five conceptual categories. Initially a pool of seventy eight 35mm slides was established. These seventy eight slides were then given to a group of three raters to sort into the five categories. All three raters agreed on the classification of thirty three slides while two of the three raters agreed on the placement of twenty nine of the slides. The other sixteen slides were discarded. To the twenty nine slides selected by two of the three raters as identifying the concept, a set of fifty six newly developed slides were added. The original thirty three unanimously agreed upon slides and the pool of eighty five slides were given a second sorting in which three additional raters were added making a total of six raters for the set of one hundred eighteen slides.

The second screening, in which no slide was used which received agreement from fewer than five of the six raters, produced forty seven slides. From these forty seven slides, the forty which varied most within each category were selected to comprise the set of exemplars for the five complex concepts.

In order to provide subjects who responded to this instrument and an orientation to the task and to provide a consistent system for the administration of the instrument, a set of instructions was developed which provides example exemplars

for the concepts of nonfreedom, irrelevant, and justice. Specific instructions for administration of the instrument were:

"In your school experience you often hear the concepts (or ideas) of justice and freedom or their opposites, nonjustice, and nonfreedom. This study in which you are participating is designed to find out how well students of your grade level understand what is meant by justice and freedom or nonjustice and nonfreedom.

You will be shown a set of slides that represent these concepts or ideas. When each slide is shown on the screen you are to decide which of these ideas it best represents and mark an X in the column headed by that concept of idea. If a slide picture does not fit any concept of idea, you are to mark an X in the last column."

"Let us try one now."

Project slide A (nonfreedom)

Ask: "What category does this slide best fit?"

"Yes, the giraffes in the pen represent the concept of nonfreedom and you should place an X under the column marked nonfreedom."

"Let's try one more."

Project slide B (irrelevant)

Ask: "What category does this slide best fit?"

"Yes, the man on the moon's surface does not fit any concept or idea so you should have marked an X in the last column which reads 'Does not fit any concept.'"

"Now, a final example!"

Project slide C (justice)

Ask: "What category does this slide best fit?"

"Yes, the picture of the lady weighing her produce purchase represents justice, so you should have marked an X in the column labelled justice."

"Are there any questions?"

"Now we are ready to see the slides. You will be shown 40 slides and you are to mark the category where each one best fits. You will be given adequate time to decide in which category you wish to place each slide. If you need more time, please raise your hand or speak out. Otherwise, you are not to talk during this study."

A further refinement of the Slide Sorting Task (SST)* was done by George (1973) following an item analysis (see Table 1) based on the responses of subjects in the Meinke, George, and Wilkinson study (1973). Eight slides which discriminated negatively were discarded. Three slides which failed to discriminate were removed from the set and used as exemplars in the instructional treatment conditions of her study since over 95 percent of the subjects had agreed upon their classification. Another pool of fifty-two new slides was developed by her and submitted to a panel of "expert" raters. Again, only the twenty-seven slides which were agreed upon by five of the six raters as denoting the concept were included in the group from which the thirteen new slides were chosen to complete the set. The slides selected were chosen because they varied most within a particular category.

*A complete description of all the stimuli is available from the authors upon request.

In the initial development of the SST only three exemplars, one each of justice, nonfreedom, and irrelevant, were used for instructional purposes. They were chosen from slides which all raters had agreed upon as representing that concept. Two of the three exemplars, justice and nonfreedom, were retained as instructional exemplars for the later study. The irrelevant exemplar was not used. Also, two of the three slides, freedom, and nonfreedom, which failed to discriminate in the original study were used as instructional exemplars. The third of these three slides was also an exemplar of nonfreedom but was eliminated as an instructional exemplar because it was similar to the other nonfreedom slide but had a higher discrimination index.

The four remaining instructional exemplar slides were chosen from the pool of exemplars. They were selected because, in addition to having received unanimous agreement from raters, they were judged to have the greatest variation from others in that particular category.

The study by George (1973) using the refined SST instrument to investigate the effect of different modes of instruction on eighth graders' ability to acquire these complex concepts yielded a reliability coefficient of .73 between original scores and delay scores after one week. When a reliability coefficient was computed according to the Kuder-Richardson formula twenty technique, a .82 reliability coefficient was obtained.

Performance Data

The first form of instrument was administered to four hundred twenty seven respondents of varying ages from seven through fourteen, seventeen and eighteen, and a group of adults. The means and standard deviations for each of these age groups are shown in Table 2. It can be seen that there is a progressive increase in performance across age groups through age thirteen. At age fourteen and eighteen the means were lower than the mean at age

thirteen. The higher trend in means continued for age seventeen and adults. It appears, then, that increases in performance with age begin to level off at age thirteen and above.

Although the individual concepts selected for this instrument can be classified as complex concepts, it is interesting to examine performances within age groups on each of the specific concepts. In Table 3 the means for each concept are shown across all age levels. A brief inspection of the table reveals that younger children, ages seven through twelve, perform better on the concepts of freedom and nonfreedom than they do on justice or injustice. From age thirteen and above performance of respondents appears to be highly similar across concepts.

Research Data

The first study by Meinke, George, and Wilkinson (1973) employed the first version of the instrument to test the effects of grade level; fourth, sixth, and eighth, of sex, boys and girls, and of levels of thinking, abstract versus concrete. They found a significant effect for grade level ($F = 14.42$, $d.f. = 2$, $p < .01$) and a significant effect for type of thinker ($F = 9.00$, $d.f. = 1$, $p < .01$). There were no significant effects found for sex or for any of the interactions. Performance on the complex concepts task increased as a function of grade level and abstract thinkers performed significantly better than concrete thinkers.

The second study by George (1973) used the revised version of the instrument. In her study she compared performances on the complex concept task of students who were identified as concrete or abstract thinkers when they were given different modes of instruction. She found significant effects for type of thinking ($F = 11.40$, $d.f. = 1$, $p < .01$) and for mode of instructions ($F = 4.72$, $d.f. = 4$, $p < .01$). Abstract thinkers performed significantly

better than concrete thinkers. Students who were provided instructions where negative instances were followed by positive instances with instructor specification of the relevant attributes of each exemplar performed significantly better than students in the control group who received no instructions. There was no significant interaction effect.

Summary and Conclusions

This study has presented the development and refinement procedures used to produce an instrument to measure performance of students on complex concepts. The refined form of the instrument yields a reliability coefficient of .73 and .83 when using a delay score and the Kuder-Richardson formula 20, respectively. Additional data were provided to show performances of students at ages seven through fourteen, seventeen and eighteen, and adults. A trend of increased performance with age was noted. Finally, both forms of the instrument have been used in research studies which have produced significant effects for type of thinker, grade levels of students, and mode of instructions.

This instrument is a valuable and practical tool for measuring pupil performance on complex concepts similar to those taught in the schools. Further, it provides a means for continued investigation of instructional strategies designed to enhance performance with complex concepts. The instrument tests the effects of instructions using a media commonly used in the teaching environment.

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TABLE 1

Item Analysis of Slide Sorting Task

Slide #	Difficulty (% right)	Item-Total Correlations	Slide #	Difficulty (% right)	Item-Total Correlations
1	53	28	21	64	57
2	73	49	22	73	45
3	49	28	23	74	55
4	61	33	24	54	25
5	68	58	25	75	24
6	40	26	26	74	47
7	56	38	27	66	29
8	64	55	28	53	17
9	66	30	29	80	61
10	64	30	30	56	35
11	84	35	31	51	42
12	64	45	32	46	23
13	78	34	33	78	42
14	54	45	34	89	68
15	89	38	35	55	39
16	83	44	36	51	11
17	49	15	37	55	20
18	26	01	38	36	25
19	79	21	39	81	42
20	79	46	40	58	24

TABLE 2

Means and Standard Deviations for Several Age Groups on Their Performance with the Complex Concept Task

Seven		Eight		Nine		Ten		Eleven		Twelve		Thirteen		Fourteen		Seventeen		Eighteen		Adults	
$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
.45	3.10	14.09	4.29	17.88	5.25	19.34	4.36	20.70	6.27	25.42	6.99	29.76	5.51	28.26	4.39	30.26	7.45	28.81	4.14	32.14	3.
31		32		32		47		37		36		54		23		77		16		42	

TABLE 3

Means for Specific Concepts by Age Group

Age Group	Concepts				
	Freedom	Non-Freedom	Justice	Non-Justice	Irrelevant
Seven	4.13	5.71	1.19	0.90	0.52
Eight	4.09	5.78	1.84	1.03	1.34
Nine	3.88	6.34	3.03	2.06	2.56
Ten	4.15	6.79	4.04	1.96	2.40
Eleven	4.51	6.41	4.68	2.59	2.51
Twelve	4.92	6.75	5.25	4.53	3.97
Thirteen	5.54	6.65	6.24	5.33	6.00
Fourteen	5.22	6.57	5.91	5.39	5.17
Seventeen	5.95	6.05	6.38	5.84	6.04
Eighteen	5.44	5.88	5.94	6.00	5.56
Adults	6.31	6.86	6.86	5.64	6.48